# A METHOD OF MAKING A MOLDED ARTICLE

## BACKGROUND OF THE INVENTION

### 1) Field of the Invention

**[0001]** The subject invention generally relates to a method of making a molded article and improving adhesion between layers in a molded article. More specifically, the subject invention relates to a method of improving adhesion between a paint layer and a polyurethane layer in the molded article.

### 2) Description of Related Art

**[0002]** Methods of making molded articles are known in the art. The relevant molded articles include a paint layer and a polyurethane layer.

**[0003]** The methods include a first step of applying a mold release agent to a surface of a mold. The mold release agent inhibits the paint layer from adhering to the surface of the mold. A paint composition is then applied to the surface of the mold to form the paint layer. Finally, the polyurethane layer is adhered to the paint layer in the mold such that the molded articles, when removed from the mold, include the polyurethane layer adhered to the paint layer and require no further painting.

**[0004]** One of the difficulties encountered in the prior art methods is that the paint layer does not properly adhere to the polyurethane layer, resulting in delamination of the paint layer from the polyurethane layer, which usually occurs during demolding of the molded articles from the mold. Furthermore, the molded articles that retain the paint layer during

demolding are susceptible to delamination during further processing or use, as shown in Example 1 below.

**[0005]** One reason for the delamination of the paint layer from the polyurethane layer is that the methods of the prior art do not include infusing the paint layer with a base. Thus, there is no catalysis of a reaction between an isocyanate component in the polyurethane layer and the paint component to increase the adhesion between the polyurethane layer and the paint layer. As such, there exists an opportunity for increasing the adhesion of the paint layer to the polyurethane layer in the molded articles.

## BRIEF SUMMARY OF THE INVENTION

**[0006]** The subject invention provides a method of making a molded article. The molded article includes a paint layer and a polyurethane layer.

**[0007]** The method includes applying a paint composition to a surface of a mold to form the paint layer. The paint layer is infused with a base. The polyurethane layer is adhered to the paint layer in the mold.

**[0008]** The base catalyzes a reaction between an isocyanate component in the polyurethane layer and the paint component to increase the adhesion between the paint layer and the polyurethane layer. Due to the infusion of the paint layer with the base, the adhesion between the polyurethane layer and the paint layer is sufficient to prevent delamination of the paint layer from the polyurethane layer during demolding of the article from the mold. Furthermore, the adhesion between the paint layer and the

polyurethane layer is sufficient for the paint layer to resist delamination during further processing or use.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

**[0009]** Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

**[0010]** Figure 1 is a perspective view of a molded article, specifically an instrument panel for an automobile, made according to the method of the subject invention;

**[0011]** Figure 2 is a cross-sectional view of section 2-2 of Figure 1;

**[0012]** Figure 3 is a cross-sectional view of another embodiment of the molded article;

**[0013]** Figure 4 is a cross-sectional view of an open mold; and

**[0014]** Figure 5 is a cross-sectional view of a closed mold.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

**[0015]** Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a method of making a molded article **10** is proposed. Referring to Figure 1, the molded article **10** of the subject invention is an instrument panel in an automobile. However, it is to be appreciated that the molded article **10** may be any variety of products, as are known in the art. Referring to Figure 2, the molded article **10** includes a paint layer **12** and a polyurethane layer **14**. Preferably, the

polyurethane layer **14** is non-foamed, as opposed to foamed, for promoting adhesion of the polyurethane layer **14** to the paint layer **12**. However, the polyurethane layer **14** may be foamed. In another embodiment, the molded article **10** may also include an additional polyurethane foam layer **16**, as shown in Figure 3.

**[0016]** The molded articles **10** may be made in any type of mold that is used for making molded articles **10**. In one embodiment, as shown in Figure 4, the molded articles **10** may be made in an open mold **18**. In another embodiment, as shown in Figure 5, the molded articles **10** may be made in a closed mold **20**. It is to be understood that the open mold **18** refers to either the open mold **18** as shown in Figure 4 or the closed mold **20** as shown in Figure 5 when the closed mold **20** is in an open position. Preferably, the molds **18, 20** are heated to a temperature that is sufficient to cure a surface of the polyurethane layer **14**. Preferably, the molds **18, 20** are heated to a temperature of at least 145°F. More preferably, the molds **18, 20** are heated to a temperature of between 145°F and 165°F. The methods of making the molded articles **10** in the respective molds **18, 20** are further discussed below.

**[0017]** Preferably, the method includes a first step of applying a mold release agent to a surface **22** of the mold **18, 20**. The mold release agent inhibits the paint layer **12** from adhering to the surface **22** of the mold **18, 20**. The mold release agent may be of any variety of mold release agents, as are well known in the art. Preferably, the mold release agent is RCTW 13091, a water-soluble wax-based mold release agent commercially available from Chemtrend. In one embodiment, the mold release agent may be sprayed

onto the surface **22** of the mold **18**, **20**. In another embodiment, the mold release agent may be included in a paint composition. In another embodiment, an internal mold release system may be employed that remains on the surface **22** of the mold **18**, **20** after molding each molded article **10**. Such methods of applying the mold release agent are known in the art.

**[0018]** The method further includes the step of applying the paint composition to the surface **22** of the mold **18**, **20**, over the mold release agent, to form the paint layer **12**. Preferably, the paint composition includes a water-based latex composition, commercially available from Redspot Paint & Varnish Company, which is commonly used in automotive applications. In another embodiment, the paint composition may include a urethane-based composition, an acrylic-based composition, a vinyl-based composition, or any other type of paint composition commonly used to form the paint layer **12**.

**[0019]** Preferably, the paint composition is applied to the surface **22** of the open mold **18**. By applying the paint composition to the surface **22** of the open mold **18**, the molded article **10** may be made in complex shapes while maintaining the quality of the paint layer **12**. The paint composition may be applied to the surface **22** of the mold **18**, **20** through a number of methods, all of which are known in the art, to form the paint layer **12**. Preferably, the paint composition is sprayed onto the surface **22** of the open mold **18** such that the paint layer **12** is substantially uniform over the surface **22** of the open mold **18**.

**[0020]** The next step is infusing the paint layer **12** with the base. By infusing, it is meant that the base mixes at least partially with the paint composition. Preferably, the base includes a metal selected from the group of alkali metals, alkaline earth metals, and mixtures thereof, which are known as catalysts for urethane reactions. More preferably, the base is selected from the group of potassium hydroxide, sodium hydroxide, lithium hydroxide, and combinations thereof, which are effective bases including the preferred metals. Most preferably, the base is potassium hydroxide, which is sufficiently non-volatile to include in the paint layer.

**[0021]** Preferably, a light, uniform coat of the base is sprayed onto the paint layer **12** to disperse the base on the paint layer **12**. The base infuses into the paint composition in the mold **18, 20**. More preferably, a light, uniform coat of a solution including at least 0.2 parts by weight of the base, based on 100 parts by weight of the solution, is sprayed onto the paint layer **12**, which is sufficient to increase the adhesion in the molded article **10**. Most preferably, the solution includes from 0.2 to 2 parts by weight of the base, based on 100 parts by weight of the solution, which is less corrosive, as compared to higher concentrations of the base in the solution, yet is still sufficient to increase the adhesion in the molded article **10**. In another embodiment, the base is mixed into the paint composition prior to the step of applying the paint composition to the surface **22** of the mold **18**. Preferably, at least 0.2 parts by weight of the base, based on 100 parts by weight of the paint composition, is mixed into the paint composition, which is sufficient to increase the adhesion in the molded article **10**. More preferably, as with spraying the

solution including the base onto the paint layer **12**, from 0.2 to 2 parts by weight of the base, based on 100 parts by weight of the paint composition, is mixed into the paint composition.

**[0022]** The polyurethane layer **14** is then adhered to the paint layer **12** in the mold **18, 20** such that the molded article **10** includes the paint layer **12** when demolded from the mold **18, 20**. The polyurethane layer **14** includes the isocyanate component and an isocyanate-reactive component. The isocyanate component may be any isocyanate component used for forming the polyurethane layer **14**, as are known in the art, including aromatic or aliphatic isocyanate components. Preferably, the isocyanate component is Elastoskin® R 51330T Isocyanate, commercially available from BASF Corporation. In one embodiment, the isocyanate-reactive component is a polyol including reactive hydroxyl groups. The polyol may be of any variety or combination of polyols as are known in the art. Preferably, the isocyanate-reactive component is Elastoskin® R 51330R Resin, commercially available from BASF Corporation. In another embodiment, the isocyanate-reactive component may include reactive amine groups. The isocyanate component and the isocyanate-reactive component may be varied in type and amount based on desired characteristics of the polyurethane layer **14**. Preferably, the polyurethane layer **14** includes an isocyanate index of at least 65, i.e., a ratio of isocyanate groups in the isocyanate component to hydroxyl groups or amine groups in the isocyanate-reactive component, to ensure that excess isocyanate groups are available. More preferably, the isocyanate index is from 65 to 250 for forming the polyurethane layer **14** ranging from a

soft urethane, formed at the isocyanate index of 65, to a rigid trimer urethane, formed at the isocyanate index of 250. Most preferably, the isocyanate index is from 95 to 105 for forming the polyurethane layer **14**.

**[0023]** Preferably, the polyurethane layer **14** is sprayed onto the paint layer **12** into which the base has been infused. A reaction is allowed to take place between the isocyanate component in the polyurethane layer **14** and the paint composition to increase the adhesion between the paint layer **12** and the polyurethane layer **14**. More specifically, the open mold **18** is preferably closed to produce the closed mold **20** prior to adhering the polyurethane layer **14** to the paint layer **12**. However, it is to be appreciated that the polyurethane layer **14** may be adhered to the paint layer **12** in the open mold **18**. Preferably, the polyurethane layer **14** is adhered to the paint layer **12** through reaction injection molding (RIM) the polyurethane layer **14** onto the paint layer into which the base has been infused. RIM includes mixing the isocyanate component and the isocyanate-reactive component to form a polyurethane composition. The polyurethane composition is then applied onto the paint layer, thereby forming the polyurethane layer **14**.

**[0024]** In one embodiment, as shown in Figure 5, the isocyanate component and the isocyanate-reactive component are mixed outside of the mold **18, 20** to form the polyurethane layer **14**. Preferably, the isocyanate component and the isocyanate-reactive component are mixed at a temperature of from 70°F to 190°F for promoting a reaction between the isocyanate component and the isocyanate-reactive component. More

preferably, the isocyanate component and the isocyanate-reactive component are mixed at a temperature of 100°F to ensure reaction of the isocyanate component and the isocyanate-reactive component. A mixing head **24** is disposed adjacent to the closed mold **20** to mix the isocyanate component and the isocyanate-reactive component. The mixing ensures uniform reaction of the isocyanate component and the isocyanate-reactive component. The polyurethane layer **14** is then injected into the closed mold **20** and onto the paint layer **12**, thereby forming the polyurethane layer **14**. More specifically, the polyurethane layer **14** is supplied through a channel **26** from the mixing head **24** into the closed mold **20**. The molded article **10** is maintained in the closed mold **20** for an amount of time sufficient for the isocyanate component and the isocyanate-reactive component to react, preferably for a period of at least 20 seconds such that the polyurethane layer **14** is sufficiently formed. More preferably, the molded article **10** is maintained in the closed mold **20** for a period of from 20 seconds to 4 minutes.

**[0025]** In another embodiment, the isocyanate component and the isocyanate-reactive component are mixed in the closed mold **20** to form the polyurethane composition in the closed mold **20**. The polyurethane composition is applied onto the paint layer **12**, thereby forming the polyurethane layer **14**. The polyurethane layer **14** is adhered to the paint layer **12** as the polyurethane layer **14** is formed.

**[0026]** The adhesion between the paint layer **12** and the polyurethane layer **14** is increased, as shown below in the Examples below, as a result of the presence of the base in the paint layer **12**. More specifically, hydroxide groups in the base, by creating a basic

environment between the paint layer **12** and the polyurethane layer **14**, allow a reaction to take place between the isocyanate component in the polyurethane layer **14** and the paint composition to increase the adhesion between the paint layer **12** and the polyurethane layer **14**. The increased adhesion both prevents delamination of the paint layer **12** from the polyurethane layer **14** as the molded article **10** is being demolded from the mold **18**, **20**, and further inhibits delamination of the paint layer **12** from the polyurethane layer **14** over time as the molded article **10** is further processed and used. As further discussed in the examples, visual observations of the paint layer **12**, based on the appearance of the paint layer **12** after demolding, were used to evaluate the adhesion of the polyurethane layer **14** to the paint layer **12**. A scratch test was used to evaluate the adhesion of the paint layer **12** under conditions that the molded article **10** will likely be exposed to over time.

## Example 1

**[0027]** Molded articles are made according to prior art methods as a benchmark for comparison to molded articles made according to the subject invention, to be introduced in further examples below. An open mold is heated to a temperature of 145°F. RCTW 13091, a water-soluble wax-based mold release agent commercially available from Chemtrend, is sprayed onto a surface of the open mold. 458W, a water-based latex paint composition commercially available from Redspot Paint & Varnish Company, is sprayed onto the surface of the open mold, over the mold release agent, to form a paint layer. The open mold is then closed to produce a closed mold. A polyurethane composition is

prepared outside of the closed mold at a temperature of 100°F by mixing an isocyanate component comprising Elastoskin® R 51330T Isocyanate and an isocyanate-reactive component comprising Elastoskin® R 51330R Resin to form a polyurethane composition at an isocyanate index of 105. The polyurethane composition is introduced into the closed mold via reaction injection molding (RIM), wherein the isocyanate component and the isocyanate-reactive component are mixed in a mixing chamber outside of the mold. The polyurethane composition is then injected through a channel into the closed mold and onto the paint layer, thereby forming a polyurethane layer, which adheres to the paint layer. The molded article is retained in the mold for a period of 45 seconds before demolding. The same procedure is performed with the mold at temperatures of 155°F and 165°F. Two molded articles are made at each temperature.

**[0028]** Visual observations of the paint layer after demolding are used to evaluate adhesion between the polyurethane layer to the paint layer. The samples are examined to determine if the paint layer is peeling or bubbling from the polyurethane layer. A scratch test is performed to determine how well the paint layer resists delamination after demolding, so long as the paint layer appears to be satisfactory after demolding. The scratch test is performed using a razor blade or a finger nail to scratch the paint layer after the molded article is allowed to cool. A measurement of resistance to scratching is recorded based on the relative ease with which the paint layer is scratched off of the polyurethane layer.

**[0029]** Referring to Table 1, the paint layer in the molded articles made with the mold at 145°F was peeling and bubbling from the polyurethane layer upon demolding the molded article from the mold. A scratch test was not used for these samples. The paint layer in the molded articles made with the mold at 155°F appeared satisfactory upon demolding. The scratch test resulted in easy scratching of the paint layer from the polyurethane layer. The paint layer in the molded articles made with the mold at 165°F also appeared satisfactory upon demolding. The scratch test resulted in more difficult scratching of the paint layer from the polyurethane layer than for the molded articles made with the mold at 155°F, however, the paint layer was still easily scratched off of the polyurethane layer.

**Example 2**

**[0030]** Molded articles are made according to the method of the subject invention. The molded articles are prepared through the same steps and the same materials as the molded articles in Example 1, the only difference being that a light, uniform coat of a solution including 1 part by weight of potassium hydroxide, based on 100 parts by weight of the solution, is sprayed onto the paint layer prior to applying the polyurethane layer for increasing the adhesion of the paint layer to the polyurethane layer, as compared to the molded articles made in Example 1.

**[0031]** The same tests as performed in Example 1 were used to evaluate the adhesion between the polyurethane layer to the paint layer in the molded articles. Referring to Table 1, the paint layer in the molded articles made with the mold at 145°F was not completely dry after demolding the molded articles from the mold. A scratch test was not

used for these samples. The paint layer in the molded articles made with the mold at 155°F also appeared satisfactory upon demolding. The scratch test resulted in difficult scratching of the paint layer from the polyurethane layer, as compared to the scratch test results of the molded articles made in Example 1. The paint layer in the molded articles made at 165°F also appeared satisfactory upon demolding. The scratch test resulted in very difficult scratching of the paint layer from the polyurethane layer, as compared to the scratch test results of the molded articles made with the mold at 155°F and the molded articles made in Example 1, thus illustrating increased adhesion of the paint layer to the polyurethane layer.

**Example 3**

**[0032]** Molded articles are made similar to the molded articles made in Example 2, the difference being that a light, uniform coat of a solution including 1 part by weight of potassium chloride, based on 100 parts by weight of the solution, is substituted for the solution including potassium hydroxide. Referring to Table 1, the adhesion between the polyurethane layer and the paint layer, as evaluated through the same tests as performed in Examples 1 and 2, was the same as for the molded articles of Example 1. There was no increase in adhesion between the paint layer and the polyurethane layer when the potassium chloride solution was sprayed onto the paint layer, showing that the potassium chloride had no effect on the adhesion between the polyurethane layer and the paint layer.

**TABLE 1**

| Temp., °F | Example 1 (Prior Art) | | Example 2 | | Example 3 | |
|---|---|---|---|---|---|---|
| | Demolding | Scratch Test | Demolding | Scratch Test | Demolding | Scratch Test |
| 145 | Pealing/ Bubbling | None | Wet | None | Pealing/ Bubbling | None |
| 155 | Satisfactory | Easy | Satisfactory | Difficult | Satisfactory | Easy |
| 165 | Satisfactory | More Difficul | Satisfactory | Very Difficul | Satisfactory | Moderate |

**[0033]** Thus, as shown through the examples, the adhesion between the polyurethane layer and the paint layer in the molded articles is increased by infusing the paint layer with the potassium hydroxide. The ineffectiveness of potassium chloride, which is known as a source of potassium, proves that the basic properties of the potassium hydroxide account for the increased adhesion. The ineffectiveness of potassium chloride is further evidence that bases similar to potassium hydroxide will result in a similar increase in adhesion between the polyurethane layer and the paint layer.

**[0034]** Obviously, many modifications and variations of the present invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims. In addition, the reference numerals in the claims are merely for convenience and are not to be read in any way as limiting.